PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

(Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference PL70091PC00	**FOR FURTHER ACTION**	See Form PCT/IPEA/416
International application No. PCT/SE2004/001783	International filing date *(day/month/year)* 02.12.2004	Priority date *(day/month/year)* 05.12.2003
International Patent Classification (IPC) or national classification and IPC G01M3/20		
Applicant SENSISTOR TECHNOLOGIES AB et al.		

1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 6 sheets, including this cover sheet.
3. This report is also accompanied by ANNEXES, comprising:
   a. ☒ *sent to the applicant and to the International Bureau)* a total of 6 sheets, as follows:
      ☒ sheets of the description, claims and/or drawings which have been amended and are the basis of this report and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions).
      ☐ sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. I and the Supplemental Box.
   b. ☐ *(sent to the International Bureau only)* a total of (indicate type and number of electronic carrier(s)) , containing a sequence listing and/or tables related thereto, in computer readable form only, as indicated in the Supplemental Box Relating to Sequence Listing (see Section 802 of the Administrative Instructions).

4. This report contains indications relating to the following items:

☒	Box No. I	Basis of the opinion
☐	Box No. II	Priority
☐	Box No. III	Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
☐	Box No. IV	Lack of unity of invention
☒	Box No. V	Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
☐	Box No. VI	Certain documents cited
☐	Box No. VII	Certain defects in the international application
☐	Box No. VIII	Certain observations on the international application

Date of submission of the demand	Date of completion of this report
23.06.2005	05.12.2005
Name and mailing address of the international preliminary examining authority: European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized Officer Helm, B Telephone No. +49 89 2399-2366

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.
PCT/SE2004/001783

Box No. I Basis of the report

1. With regard to the **language**, this report is based on the international application in the language in which it was filed, unless otherwise indicated under this item.

   ☐ This report is based on translations from the original language into the following language , which is the language of a translation furnished for the purposes of:
   - ☐ international search (under Rules 12.3 and 23.1(b))
   - ☐ publication of the international application (under Rule 12.4)
   - ☐ international preliminary examination (under Rules 55.2 and/or 55.3)

2. With regard to the **elements*** of the international application, this report is based on *(replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report)*:

Description, Pages

1-4, 6-12, 14, 15	as published
5, 13	filed with telefax on 23.06.2005

Claims, Numbers

1-22	filed with telefax on 23.06.2005

Drawings, Sheets

1/2, 2/2	as published

☐ a sequence listing and/or any related table(s) - see Supplemental Box Relating to Sequence Listing

3. ☐ The amendments have resulted in the cancellation of:
   - ☐ the description, pages
   - ☐ the claims, Nos.
   - ☐ the drawings, sheets/figs
   - ☐ the sequence listing *(specify)*:
   - ☐ any table(s) related to sequence listing *(specify)*:

4. ☐ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).
   - ☐ the description, pages
   - ☐ the claims, Nos.
   - ☐ the drawings, sheets/figs
   - ☐ the sequence listing *(specify)*:
   - ☐ any table(s) related to sequence listing *(specify)*:

* *If item 4 applies, some or all of these sheets may be marked "superseded."*

Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-22
	No:	Claims	
Inventive step (IS)	Yes:	Claims	1-22
	No:	Claims	
Industrial applicability (IA)	Yes:	Claims	1-22
	No:	Claims	

2. Citations and explanations (Rule 70.7):

see separate sheet

Re Item V.

1. Prior Art

Reference is made to the following documents:

D1 = US5553483 A
D2 = US4754638 A
D3 = US3762212 A
D4 = US6314794 B1
D5 = US5939619 A
D6 = US5767391 A

2. Technical Field

The invention relates to a system for and a method of determining the leakproofness of an object having a first cavity, wherein a closed chamber having a second cavity is arranged to envelope said object within said second cavity, wherein a tracer gas is supplied into the one of said cavities and wherein a transport gas other than said tracer gas is introduced into the other of said cavities for transporting any tracer gas in said other of said cavities towards a detecting means.

3. Closest and Most Relevant Prior Art

Such a system and method are disclosed in document D1.

4. Novelty (Article 33(1),(2) PCT)

The present invention as it is defined in the independent claims 1 and 13 differs from the known apparatus and method essentially by the following features:

(i) evacuating means are provided to lower the pressure inside one of said first and second cavities with respect to the ambient pressure, said evacuating means being arranged to compress arriving gas to the ambient pressure of the other chamber;

(ii) the detecting means are arranged to communicate with the one of said cavities rendered the lower pressure via the evacuating means and to operate at the ambient pressure of said other chamber;

(iii) the tracer gas is hydrogen.

Thus, present independent claims 1 and 13 are novel.

5. Inventive Step (Article 33(1),(3) PCT)

The technical effects of these features are the following: By evacuating one of said chambers the dead volume can be reduced by the reduction of the total gas pressure in said chamber. A simple and cheap detector can be used, since the detector is operated at ambient pressure and not under vacuum conditions. In addition, the evacuation of said chamber achieves a relatively high test speed as well as a high sensitivity.

No document discloses or suggests an evacuating means being arranged to compress arriving gas to ambient pressure so as to operate the detecting means at ambient pressure.

Documents D1 and D2 do not disclose evacuation of any chamber during testing, whereas documents D3 to D6 suggest detection under vacuum conditions, but mention neither a transport gas nor a compression of arriving gas to ambient pressure so as to operate the detecting means at ambient pressure.

Accordingly, an inventive step of present independent claims 1 and 13 is acknowledged.

6. Dependent Claims

Dependent claims 2 to 12 and 14 to 22 relate to additional features of the independent claims to which they refer and are therefore deemed to be novel and inventive.

7. Industrial Applicability (Article 33(1),(4) PCT)

Beyond any doubt, the invention, as it is defined in claims 1 to 22, is industrially applicable; e.g. in determining the leakproofness of a device under test.

8. Further Remarks and Objections

Contrary to the requirements of Rule 5.1(a)(ii) PCT, the relevant background art disclosed in the documents D1 to D4 is not mentioned in the description, nor are these documents identified therein.

Claims

1. A system (1) for determining the leakproofness of an object (2) having a first cavity (3), said system (1) comprising

a closed chamber (4) having a second cavity (5), which chamber (4) is arranged to envelope said object (2) within said second cavity (5),

evacuating means (6) being arranged to lower the pressure inside one of said first cavity (3) and second cavity (5) with respect to the ambient pressure,

supplying means (7) for supplying a tracer gas (8) into the one of said cavities (3, 5) rendered the higher pressure, and

detecting means (9) being sensitive to said tracer gas (8),

characterized in, that said system (1) further comprises introduction means (10) being arranged to introduce a transport gas other than said tracer gas (8) into the one of said cavities (3, 5) rendered the lower pressure, and said evacuating means (6) further being arranged to compress arriving gas to the ambient pressure of the chamber (4), and said detecting means (9) being arranged to communicate with the one of said cavities (3, 5) rendered the lower pressure via the evacuating means (6) and being arranged for operation at the ambient pressure of said chamber (4), and said tracer gas (8) being hydrogen.

2. A system (1) according to claim 1, **characterized in,** said introduction means (10) being arranged to introduce the transport gas into the one of said cavities (3, 5) rendered the lower pressure during at least one controlled time interval.

3. A system (1) according to claim 2, **characterized in,** said introduction means (10) being arranged to introduce the transport gas in a continuous flow into the one of said cavities (3, 5) rendered the lower pressure during the at least one controlled time interval.

4. A system (1) according to claim 2, **characterized in,** said introduction means (10) being arranged to introduce a controlled amount of the transport gas into the one of

said cavities (3, 5) rendered the lower pressure during a first part of the at least one controlled time interval.

5. A system (1) according to claim 4, **characterized in,** said introduction means (10) further being arranged to introduce a continuous flow of the transport gas into the one of said cavities (3, 5) rendered the lower pressure during a second part of the at least one controlled time interval.

6. A system (1) according to claim 4, **characterized in,** said evacuating means (6) further being arranged to evacuate tracer gas (8) from the one of said cavities (3; 5) rendered the lower pressure towards said detecting means (9) during an evacuation time interval.

7. A system (1) according to any of the preceding claims, **characterized in,** that the transport gas is air or nitrogen.

8. A system (1) according to any of the preceding claims, **characterized in,** that the system (1) further comprises a first valve (19) located in an inlet (21) of the one of said cavities (3, 5) rendered the lower pressure and a second valve (20) located in an outlet (22) of the one of said cavities (3, 5) rendered the lower pressure.

9. A system (1) according to any of the preceding claim, **characterized in,** that the system (1) further comprises a filter (24) in an inlet (23) of the introduction means (10).

10. A system (1) according to any of the preceding claims, **characterized in,** that said first cavity (3) is rendered the lower pressure.

11. A system (1) according to any of claims 1-9, **characterized in,** that said second cavity (5) is rendered the lower pressure.

12. A system (1) according to any of the preceding claims, **characterized in,** that said object (2) is an aluminium wheel or an aluminium-alloy wheel.

13. A method for determining the leakproofness of an object (2) having a first cavity (3), said method comprising the steps of:

enveloping said object (2) within a second cavity (5) of a closed chamber (4),

establishing by evacuating means (6) a lower pressure inside one of said first cavity (3) and second cavity (5) with respect to the ambient pressure,

supplying a tracer gas (8) by supplying means (7) into the one of said cavities (3, 5) rendered the higher pressure, and

detecting said tracer gas (8) in the one of said cavities (3, 5) rendered the lower pressure with detecting means (9) being sensitive to said tracer gas (8),

characterized in, that the step of detecting said tracer gas (8) is preceded by a step of introducing a transport gas other than said tracer gas (8), into the one of said cavities (3, 5) rendered the lower pressure, by introduction means (10) for transporting any tracer gas (8) in the one of said cavities (3, 5) rendered the lower pressure towards the detecting means (9) via the evacuating means (6), a step of compressing gas arriving at the evacuating means (6) to the ambient pressure of the chamber (4) and a step of pumping compressed gas to the detecting means (9) by the evacuating means (6), that the step of detecting said tracer gas (8) comprises detecting at the ambient pressure of the chamber (4) and that the tracer gas is hydrogen.

14. A method according to claim 13, **characterized in,** that the step of introducing the transport gas into the one of said cavities (3, 5) rendered the lower pressure is performed during at least one controlled time interval.

15. A method according to claim 14, **characterized in,** that the step of introducing the transport gas into the one of said cavities (3, 5) rendered the lower pressure during the at least one controlled time interval further comprises introducing the transport gas in a continuous flow for transporting tracer gas (8) in the one of said cavities (3, 5) rendered the lower pressure towards said detecting means (9).

16. A method according to claim 14, **characterized in,** that the step of introducing the transport gas into the one of said cavities (3, 5) rendered the lower pressure during the at least one controlled time interval further comprises introducing a controlled amount of transport gas during a first part of the at least one controlled time interval for compressing accumulated tracer gas (8) in the one of said cavities (3, 5) rendered the lower pressure in order to produce a short and concentrated pulse.

17. A method according to claim 16, **characterized in,** that that the step of introducing the transport gas into the one of said cavities (3, 5) rendered the lower pressure during the at least one controlled time interval further comprises introducing the transport gas in a continuous flow during a second part of the at least one controlled time interval for transporting said pulse towards the detecting means (9).

18. A method according to claim 16, **characterized in,** that the method further comprises a step of evacuating transport gas by the evacuating means (6) from the one of said cavities (3, 5) rendered the lower pressure during at least one controlled evacuation time interval for transporting said pulse towards the detecting means (9).

19. A method according to any of the preceding claims, **characterized in,** that the step of introducing a transport gas other than said tracer gas (8) into the one of said cavities rendered the lower pressure is preceded by a step of accumulating tracer gas (8) in the one of said cavities (3, 5) rendered the lower pressure.

20. A method according to any of the preceding claims, **characterized in,** that the step of introducing a transport gas further comprises eliminating contaminants in the transport gas using a filter (24) before the introduction.

21. A method according to any of the preceding claims, **characterized in,** that the step of establishing a lower pressure inside one of said first and second cavities (3, 5) comprises establishing the lower pressure in the first cavity (3).

22. A method according to any of claims 13-20, **characterized in,** that the step of establishing a lower pressure inside one of said first and second cavities (3, 5) comprises establishing the lower pressure in the second cavity (5).

within said second cavity; evacuating means being arranged to lower the pressure inside one of said first and second cavities with respect to the ambient pressure; supplying means for supplying a tracer gas into the one of said cavities rendered the higher pressure; and detecting means being sensitive to said tracer gas.

This object is achieved in accordance with the characterizing portion of claim 1.

Thanks to that the system further comprises introduction means being arranged to introduce a transport gas other than the tracer gas into the one of the cavities rendered the lower pressure, and said evacuating means further being arranged to compress arriving gas to the ambient pressure of the chamber, and said detecting means being arranged to communicate with the one of said cavities rendered the lower pressure via the evacuating means and being arranged for operation at the ambient pressure of said chamber and said tracer gas being hydrogen, it is possible to achieve a relatively high test speed and high sensitivity as well as a low equipment and maintenance cost.

It is a further object of the present invention to provide an improved method for determining the leakproofness of an object having a first cavity, said method comprising: enveloping said object within a second cavity of a closed chamber; establishing by evacuating means a lower pressure inside one of said first and second cavities with respect to the ambient pressure; supplying a tracer gas by supplying means into the one of said cavities rendered the higher pressure; and detecting said tracer gas in the one of said cavities rendered the lower pressure with detecting means being sensitive to said tracer gas.

This object is achieved in accordance with the characterizing portion of claim 13.

Thanks to that the method further comprises that the step of detecting said tracer gas is preceded by a step of introducing a transport gas other than said tracer gas, into the one of the cavities rendered the lower pressure, by introduction means for transporting any tracer gas in the one of said cavities rendered the lower pressure towards the detecting means via the evacuating means, a step of compressing gas arriving at the evacuating means to the ambient pressure of the chamber and a step of pumping compressed gas to the detecting means by the evacuating means, that the step of detecting the tracer gas comprises detecting at the ambient pressure of the chamber and that the tracer gas is hydrogen, it is possible to achieve a relatively high test speed and high sensitivity as well as a low equipment and maintenance cost.

Preferred embodiments are listed in the dependent claims.

Still other objects and features of the present invention will become apparent from the following detailed description considered in conjunction with the accompanying drawings. It is to be understood, however, that the drawings are designed solely for purposes of illustration and not as a definition of the limits of the invention, for which reference

In order to be able to detect any leaks, a detectable tracer gas 8 is then supplied by means of supplying means 7 into the first cavity 3. The tracer gas 8 is usually pressurized. If there are any leaks in the object 2, a leak flow of tracer gas 8 will then be provided into the second cavity 5 due to the pressure difference. According to the invention, hydrogen is used as tracer gas. Any leaking tracer gas 8 is allowed to accumulate in the second cavity 5 during an accumulation time through closing a first valve 19 located in an inlet 21 and a second valve 20 located in an outlet 22.

Even if the dead volume in the second cavity 5 is reduced by lowering the pressure, it is according to the following invention not reduced to very low pressure, i e high vacuum, and thus the dead volume is not reduced to such an extent that the important parameter test speed is satisfactory high. In order to even further increase the test speed, a continuous flow of a transport gas is introduced after the accumulation time by the introduction means 10 into the second cavity 5 during a controlled time interval. Any accumulated tracer gas 8 in the second cavity 5 is then transported towards the detecting means 9 being sensitive to the tracer gas 8 via the evacuating means 6 by the transport gas. Before the introduction of the transport gas, contaminants may optionally be eliminated using a filter through oxidation. The introduction of the transport gas reduces the time it takes for any tracer gas 8 in the second cavity 5 to reach the detecting means 9 and implies therefore that the test speed is increased. The flow of the transport gas is regulated by the flow regulating means 18. Any leaking tracer gas 8 arriving at the evacuating means 6 through an inlet 11 of the evacuating means 6 is compressed by a pump 13 to the ambient pressure of the chamber 4, pumped out through an outlet 12 of the evacuating means 6 and detected by the detecting means 9 at the ambient pressure. The ambient pressure is usually the atmospheric pressure.

In a second embodiment the method in accordance with the present invention is suited to be used when one so-called steady-state analysis method is to be applied for determining the leakproofness of an object 2 having a first cavity 3. The second embodiment resembles the first embodiment except for that it does not comprise a step of accumulation of tracer gas 8. Thus, the transport gas is introduced without being preceded by any accumulation of tracer gas. Furthermore, the extent of the leakproofness of the tested object is then determined when a steady-state concentration of tracer gas 8 is achieved in the flow of transport gas, i e the leakproofness is determined by the detecting means 9 through detecting the concentration of tracer gas 8 in the flow of transport gas when there is a steady-state concentration of tracer gas.